CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-233
ALEXANDER-REDWOOD HILL FAULT
SONOMA COUNTY, CALIFORNIA

by
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Associate Geologist
May 7, 1992

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INTRODUCTION

Potentially active traces of the Alexander-Redwood Hill fault in the Shiloh Ranch/Brooks Creek study area are evaluated in this Fault Evaluation Report (FER) (Figure 1). Traces of the Alexander-Redwood Hill fault are located in the Mark West Springs, Healdsburg, and Jimtown 7.5-minute quadrangles (Figure 1). Faults previously zoned for special studies in these quadrangles include the northern Rodgers Creek/Healdsburg and Maacama faults (CDMG, 1983a, 1983b, 1983c; summarized by Bryant, 1982). Re-evaluation of the Rodgers Creek/Healdsburg and Maacama faults is not warranted at this time due to a lack of new data.

Faults in the Shiloh Ranch/Brooks Creek study area are evaluated as part of a statewide effort to evaluate faults for recency of activity. Those faults determined to be sufficiently active (Holocene) and well-defined are zoned by the State Geologist as directed by the Alquist-Priolo Special Studies Zones Act of 1972 (Hart, 1990).

SUMMARY OF AVAILABLE LITERATURE

The Shiloh Ranch/Brooks Creek study area is located 50 km north of San Francisco Bay in the Coast Ranges geomorphic province. Deformation in the study area is dominated by the right-lateral strike-slip San Andreas fault system (Fox, 1983). The Alexander-Redwood Hill fault is located approximately half-way between the active Rodgers Creek/Healdsburg fault zone to the west and the active Maacama fault zone to the east.

Topography in the study area is mountainous and is characterized by rolling hills of moderate to locally rugged relief. Alexander Valley is situated at the northern end of the study area and occupies the floodplain of the Russia River. Elevations in the study area range from about 50 meters in Alexander Valley to over 300 meters in the southern part of the study area. Development generally is moderate. Agriculture (vineyards, orchards, and livestock grazing) and low to medium density housing are the principal land uses in the study area.

Rock types in the study area include Mesozoic Franciscan Complex and Great Valley Sequence sedimentary rocks, late Miocene and Pliocene Sonoma Volcanics, Plio-Pleistocene Glen Ellen Formation, and unconsolidated late Pleistocene and Holocene alluvium, colluvium, and landslide deposits (Blake and others, 1971; Fox and others, 1973; Armstrong, 1977, 1978; Huffman and Armstrong, 1980).

Aerial photographic interpretation by this writer of faults in the Shiloh Ranch/Brooks Creek study area was accomplished using aerial photographs from the U.S. Department of Agriculture (1952), U.S. Geological Survey (1953, 1973), and CDMG (1976). Fault traces mapped by other workers were photo checked for geomorphic evidence of Holocene activity and location accuracy. Traces in the Mark West Springs quadrangle mapped by this writer were plotted directly on the aerial photographs and then transferred to 7.5-minute base maps using a Bausch and Lomb Zoom Transfer Scope.

Two and one half days were spent in the field in early March 1992 by this writer. Selected faults were field checked and subtle features not observable on aerial photographs were mapped. Results of aerial photographic interpretation and field observations by this writer are summarized on Figures 2a-2c and Figure 3.

LITERATURE REVIEW

The Alexander-Redwood Hill fault in the study area is a 20 km long, northwest-trending fault with displacement reported to vary from right-lateral strike-slip to oblique slip with a normal (up-on-the-east) dip-slip component. Cumulative strike-slip or vertical offset along this fault is not known. The northwest trending fault from Alexander Valley to Mark West Creek has variously been called the Alexander fault, Redwood Hill fault, Chalk Hill-Redwood Hill fault, and the Alexander-Redwood Hill fault. The fault will be referred to as the Alexander-Redwood Hill fault (after Olsborg and Vincilione, 1988) in this FER. Workers who mapped all or parts of the fault include: Gealey (1951); Blake and others (1971); Fox and others (1973); Armstrong (1977, 1978); Herd and others (1977); and Olsborg and Vincilione (1988). Pampeyan (1979) classified strands of the Alexander-Redwood Hill fault in the study area as Quaternary active. Faults depicted by Huffman and Armstrong (1980) were compiled from Blake and others (1971) and Fox and others (1973) and will not be evaluated in this FER.

Gealey (1951)

Gealey (1951) first mapped a northwest trending fault that he named the Alexander fault. Traces mapped by Gealey (1951) are essentially the same as traces mapped by Blake and others (1971) and are not plotted on Figures 2a and 2b. The fault mapped by Gealey extends southeast of Alexander Valley in the study area. Gealey assumed that the fault lies beneath the alluvium of Alexander Valley and extends northwest beyond the study area. Bryant (1982) and Smith (1982) evaluated traces of the Alexander fault northwest of the study area and concluded that the fault lacked evidence of Holocene displacement. Gealey reported that the Alexander fault was principally a dip-slip fault (up to the east), although he did not state the amount of vertical displacement.

Blake and others (1971)

Mapping by Blake and others (1971) is essentially the same as mapping by Gealey (shown in brown in Figures 2a and 2b). Blake and others delineated faults that they considered to be late Quaternary active in the Sonoma County study area. The Alexander-Redwood Hill fault was not one of the faults they considered to have been active during late Quaternary time.

Significantly, Blake and others did not map a fault along most of the eastern side of Brooks Creek (Figure 2b). An exception is along the southeastern side of the valley where they mapped Cretaceous Great Valley rocks faulted against Plio-Pleistocene Glen Ellen Formation (locality 1, Figure 2b). This fault is very short (about 0.7 km) and is concealed by alluvium in Brooks Creek.

The northern end of the Alexander-Redwood Hill fault just south of Alexander Valley was mapped by Blake and others as crossing a serpentine body (locality 2, Figure 2a). This mapped unit is not offset, or offset is minor enough to not be discernable at a scale of 1:62,500. This contrasts somewhat from mapping by Gealey, who depicted about 47 meters of apparent left-lateral offset of the serpentine body. From this evidence, it can be inferred that strike-slip displacement is minor along much of the fault in the northern part of the study area and may actually be dying out just south of Alexander Valley. Alternatively, faulting may be very distributive at the northern end of the fault and no individual trace or branch has had significant late Quaternary displacement.

Herd and others (1977)

Herd and others (1977) mapped a 3.8 km long strand of the Alexander-Redwood Hill fault in the Mark West Springs quadrangle considered to be Quaternary active, based mainly on air photo interpretation (mapping by Herd and others is shown in light green in Figure 2c). The fault consists of two left-stepping strands. The western segment is delineated by a ridgetop trough, a closed depression, associated tonal lineaments, and scarps in bedrock (Figure 2c). The eastern segment is delineated by a broad northeast-facing scarp in Pliocene Sonoma Volcanics with associated linear drainages and saddles (Figure 2c).

Armstrong (1977, 1978)

Armstrong (1977, 1978), who termed the fault the Chalk Hill-Redwood Hill fault zone, reported that the Alexander-Redwood Hill fault is delineated by geomorphic evidence of late Quaternary activity, such as sag ponds, right-laterally deflected streams and ridges, benches, and scarps (mapping by Armstrong is shown in red in Figure 2b and pink and red in Figure 2c).

The fault mapped by Armstrong generally offsets bedrock (Pliocene Sonoma Volcanics and Plio-Pleistocene Glen Ellen Formation). Holocene alluvium is juxtaposed against Glen Ellen Formation along the east side of Brooks Creek at locality 3 (Figure 2b). This suggests recent offset, but lateral stream erosion can readily explain the juxtaposition. Elsewhere in the Brooks Creek area alluvium conceals fault traces (Figure 2b). However, this alluvium is late Holocene to modern and lack of offset does not necessarily demonstrate a lack of Holocene activity.

Armstrong (1978) reported that the fault in the Brooks Creek area is delineated by scarp-like cliffs and an abrupt change in stream gradient, suggesting relatively rapid uplift on the east side of the fault, possibly as recent as Holocene (locality 4, Figure 2b). Armstrong reported a fault exposure along the east side of Brooks Creek within units of the Glen Ellen Formation. This was documented in a photograph (Figure 11, p. 14, Armstrong, 1978). It is not known where exactly this exposure is - I was unaware of the photo until after I did the field check, so the fault exposure was not field checked. Armstrong reported that a fault contact between conglomerate and sandstone beds of the Glen Ellen Formation is located at the base of the west-facing escarpment on the east side of Brooks Creek. The fault in Figure 11 appears to be a bedding plane fault, based on the fact that the mapped fault strikes parallel to the bedding and data provided in the photo caption, which states that the fault lies between conglomerate and sandstone beds of the Glen Ellen Formation.

In the Mark West Springs quadrangle Armstrong (1977) mapped late Quaternary (Holocene ?) alluvium as concealing the fault just north of the linear ridgetop trough (locality 5, Figure 2c). The northwestern trace of the fault mapped by Armstrong in the Mark West Springs quadrangle is delineated by a right-laterally deflected ridge that was described by Armstrong as a "deflected interfluve" (locality 6, Figure 2c). This right-laterally deflected ridge was verified by this writer (Figures 2c, 3). However, it is a large-scale deflection (approximately 260 meters) that is relatively isolated. There is a lack of systematically offset drainages and ridges along the trend of the fault. The deflected interfluve lacks any small-scale geomorphic features indicative of Holocene displacement, such as a closed depression or trough in the saddle between the connecting ridges. These observations are based on field checking by this writer. Additionally, small-scale geomorphic features northwest and southeast of the fault, such as sidehill benches or sidehill troughs, are not present.

Fox and others (1973)

Fox and others (1973) mapped a 2.5 km long fault east of the traces mapped by Herd and others (1977) and Armstrong (1978) (shown in brown in Figure 2c). The fault offsets units of the Sonoma Volcanics, but doesn't cross younger deposits. A branch fault mapped by Armstrong (1977) is located within about 300 meters of the fault mapped by Fox and others (Figure 2c).

Olsborg and Vincilione (1988, 1990)

An investigation for small dam sites along the southern part of the Alexander-Redwood Hill fault was performed by Olsborg and Vincilione (1988) (Figure 2c, Photos 1 and 2). In addition to trenching normal to traces of the fault within the linear ridgetop trough, Olsborg and Vincilione (1988) mapped the fault northwest to Alexander Valley (shown in black in Figures 2a-2c). Olsborg and Vincilione (1988) excavated three trenches across a N25°W-trending ridgetop trough. Olsborg and Vincilione (1988) concluded that the last major displacement along the Alexander-Redwood Hill fault occurred in early to mid Holocene time. They believe that displacement along the Alexander-Redwood Hill fault was probably due to sympathetic movement from strong earthquakes generated on a nearby portion of either the Healdsburg or Maacama faults. No supporting data were provided with respect to this assumption,.

Trench T-1 is a 51.8 meter long trench excavated to a maximum depth of 3.4 meters. The trench exposed tuff and andesitic units of the Sonoma Volcanics that border the western and eastern sides of the trough. The center of the trough consists of colluvial/alluvial deposits described as dark red brown sandy clay (up to 1.2 meters) (unit G) that overlies what has been described as a red brown andesite breccia, crushed, friable, deeply weathered (unit J). Howard (1987) inspected trench T-1 as it was being excavated in 1987 and interpreted the entire section exposed in the center of the trough to be a colluvial unit.

Faults at stations 30 (0 measured from the east) and 100 are logged as offsetting unit J but not extending into the overlying unit G. Significantly, Howard logged two small stream channels (alluvial lenses) in the unit J andesite breccia near the western fault, indicating that the entire section is alluvial and is faulted. The fault at station 100 strikes N14°W, is near vertical and juxtaposes tuff on the west against colluvial sandy clay and andesite breccia (?) on the east. The fault as logged by Olsborg and Vincilione (1988) does not extend into the overlying red brown sandy clay colluvial unit G. Howard, based mainly on a phone conversation with Olsborg because that portion of the trench was not completed during Howard's field inspection, showed shears extending into the unit G colluvium and coming very near the ground surface. Significantly, Howard noted that the easternmost strand of this western fault had a 9.5 mm sand-filled fissure. The fault at station 30 strikes N02°W and dips east about 65° to the east. The fault juxtaposes tuff with a distinctive "bake zone" on the east against colluvium on the west. The fault plane did not extend into the uppermost 2 meters of the trench.

Two additional faults were reported at the western end of the trench at stations 150 and 160. The westernmost shear is entirely within Sonoma Volcanics, but the shear at station 150 is associated with a bedrock step and a possible soil in-filling.

Trench T-2 is a 53 meter long trench excavated to a maximum depth of 3 meters. Faults were reported at stations 45 and 95 (0 at east end of trench). The eastern fault at station 45 juxtaposes white to light grey tuff on the east against colluvial deposits (unit J) on the west. The fault strikes N36°W and dips steeply to the east. The shear plane terminates about 1.8 meters below the ground surface - it does not extend into the overlying red brown sandy clay (unit G). The fault at station 95 is delineated by an approximately 2 meter wide zone of orange and gray clay-filled fractures that range in width from 6 to 13 mm. The fault separates gray andesite flows on the west and colluvium (unit J) on the east. Olsborg and Vincilione (1988) stated that this zone is characterized by several dark-colored, fine sand-filled fractures extending from the main trace into the colluvium (unit P or J, described as an andesite breccia). These fractures are overlain by approximately 1.2 meters of colluvium. Olsborg and Vincilione (1988) argued that the upper, undisturbed colluvial deposits indicated that the last major movement along this fault probably occurred in early to mid Holocene time.

Trench T-3 is a 75 meter long trench excavated to a maximum depth of 3.9 meters. Two faults were exposed, one at station 75 and one at station 170 (0 measured at east end of trench). The eastern fault strikes north-south and dips 76° to the west. This fault juxtaposes layered tuff and andesite deposits on the east against colluvial deposits on the west. Shears extend to within 0.6 meters of the ground surface. A colluvial deposit described as a dark red brown gravelly sandy clay drastically thickens across the fault, indicating offset of the colluvial unit. The western fault strikes N30°W and dips 86°E. Here the fault plane is delineated by a 15 to 30 cm thick red-black clay (no slickensides reported) that juxtaposes andesite on the west against colluvium on the east. Two shear planes within the trough are delineated by clay-filled fissures (?) at stations 160 and 90. Neither of these features extend into the upper colluvial unit.

Olsborg and Vincilione (1988) produced a map with annotations of geomorphic evidence of recent faulting (Figures 2a- 2c). They stated that the fault in the Mark West Springs quadrangle is delineated by geomorphic features indicative of Holocene strike-slip faulting, including the linear ridgetop trough and associated ponded alluvium, springs, and closed depressions they termed "vernal pools" (Figure 2c). Most of the geomorphic features delineating the Alexander-Redwood Hill fault northwest of the ridgetop trough are indicative of fault line features (Figures 2a-2c). Specific features that may indicate late Pleistocene to Holocene activity other than the ridgetop trough are summarized below.

The Brooks Creek area is critical in the evaluation of fault recency (Figure 2b). Olsborg and Vincilione (1988), like Armstrong (1978), indicated that faults in the Brooks Creek area are Holocene active, based on linear southwest-facing scarps and a "hanging drainage ravine" (Figure 2b). They reported that the Brooks Creek drainage is a linear valley or graben bounded on the west and east by faults. The eastern trace crosses and may offset alluvium of Brooks Creek (locality 7, Figure 2b). It is not certain if the fault was mapped as offsetting the alluvium or concealed by the alluvium of Brooks Creek because Olsborg and Vincilione (1988) used only a dashed line to represent the fault. I did not verify a fault in alluvium at locality 7 (Figure 2b).

Olsborg and Vincilione (1988) reported that the fault trace between the linear trough and Brooks Creek is delineated by right-laterally deflected drainages and deflected ridges. The one right-laterally deflected ridge I was able to verify is the same one reported by Armstrong at locality 6 (Figure 2c). Associated right-laterally deflected drainages reported by Olsborg and Vincilione (1988) were not verified (Figure 2b, 2c). This section of the fault is moderately defined and is delineated by geomorphic features of Quaternary right-lateral strike-slip offset, but lacks specific evidence of systematic Holocene right-lateral strike-slip displacement.

Olsborg and Vincilione (1988) mapped the fault as extending across the Russian River toward Alexander Valley (Figures 2a and 2b). The fault is delineated by linear ridges in bedrock, saddles, deflected drainages, and linear valleys (e.g. localities 8-10, Figures 2a and 2b). Olsborg and Vincilione (1988) locally mapped linear valleys or grabens and right-laterally deflected drainages (Figure 2c). These geomorphic features were not verified by this writer. The trace of the Alexander Valley fault northwest of the Russian River is poorly defined and is not delineated by geomorphic features indicating recent faulting, either strike-slip or normal.

Olsborg and Graff (1990)

Olsborg and Graff (1990) excavated one 10.7 meter long trench across the trace of the Alexander-Redwood Hill fault within the northern linear trough at locality 11 (Figure 2c). The highly generalized trench log depicts a vertical fault (N40°W) located 2.7 meters from the west end of the trench. The fault, which extends to within 0.7 meters of the ground surface, offsets light grey andesite on the west against red clayey andesite breccia overlain by black vesicular andesite breccia (colluvial units?). The fault plane is characterized by a 6 to 13 mm wide brown clay seam or fissure (?). A brown gravelly sandy clay colluvial unit overlies the fault. The base of this colluvial unit steps down slightly to the east across the fault and may be offset. However, no shears or fault planes were reported to extend upward into the colluvial unit. Although the trench was only 10.7 meters long, Olsborg and Graff (1990) stated the fault zone here is approximately 38 meters wide.

AERIAL PHOTOGRAPHIC INTERPRETATION AND FIELD INSPECTION

Aerial photographic interpretation by this writer was done primarily to verify the location and activity of traces mapped by other workers (Figures 2a to 2c). Those traces verified with respect to location and activity are indicated by a red check mark. Those traces not verified with respect to activity or location are indicated by NV. Most of the Alexander-Redwood Hill fault is moderately to poorly defined and lacks geomorphic evidence of latest Pleistocene to Holocene right-lateral strike-slip or vertical offset (Figures 2a-2c). The exception is the linear ridgetop trough in the Mark West Springs quadrangle

(Figure 2c). Figure 3 depicts the interpretation by this writer of features in the Mark West Springs quadrangle.

There are three principal areas along the Alexander-Redwood Hill fault that are indicative of recent faulting, based on the work of others. These include: (1) the linear ridgetop trough in the Mark West Springs quadrangle mapped by Armstrong (1977), Herd and others (1977), and Olsborg and Vincilione (1988) (Figure 2c), (2) the right-laterally deflected interfluve or ridge reported by Armstrong (1978) and Olsborg and Vincilione (1988) (Figure 2b), and (3) vertically offset tributary drainages and associated linear west-facing scarps in the Brooks Creek area reported by Armstrong (1978) and Olsborg and Vincilione (1988) (Figure 2b). The right-laterally deflected interfluve was discussed in the literature review section under Armstrong (1977, 1978).

Linear Ridgetop Trough

The linear ridgetop trough in the southwestern part of the Mark West Springs quadrangle is delineated by generally well-defined geomorphic features including a closed depression, linear vegetation contrasts, and ponded alluvium within a broad linear trough (Figures 2c and 3). Agreement with respect to location of faults by this writer and others is good south of locality 11, but the fault is less well-defined to the northwest and generally lacks geomorphic evidence of Holocene right-lateral strike-slip displacement, although late Quaternary offset is indicated (Figures 2c, 3). The linear trough south of locality 11 has probably formed by extension; differential vertical displacement reported by Olsborg and Vincilione (1988) is not apparent (Figure 4).

Soils developed on colluvial deposits within the ridgetop trough have been mapped as the Spreckels loam (Miller, 1972), which is characterized by an argillic B soil horizon with continuous, thick to moderately thick clay films. This degree of soil development suggests a latest Pleistocene to early Holocene age for the upper colluvial unit described by Olsborg and Vincilione (1988).

It seems clear that the linear trough is latest Pleistocene to Holocene, based on the geomorphic expression and the offset of colluvial units reported by Olsborg and Vincilione (1988) and Olsborg and Graff (1990). What is not certain is the cause or origin of the linear trough. It has been postulated by Herd (p.c., 1982) that this trough is an extensional feature related to a large-scale right step transferring activity from the Rodgers Creek fault to the Maacama fault. Herd and others mapped relatively short ($\approx$ 2km) left-stepping strands located about half way between traces of these two major strike-slip faults (Figure 2c). However, the fault delineated by the linear ridgetop trough continues to the northwest beyond the mapping of Herd and others.

Although the fault northwest of locality 11 lacks geomorphic evidence of Holocene displacement, it is also evident that the fault defined by the linear ridgetop trough is delineated by geomorphic features more consistent with extension rather than right-lateral strike-slip displacement. This suggests that the portion of the fault south of locality 11 may have formed or been enhanced by ridgetop spreading (Hart and others 1990). Topographic profiles normal to the fault trend (Figure 4) are somewhat consistent with features indicative of lateral spreading: a ridgetop trough or trench bounded by steep slopes (Mark West Creek) that would allow outward migration of the slope and downdropping or settlement along planes of weakness near the ridgetop. However, bedding or flow layering in the Sonoma Volcanics is either near horizontal or dips moderately to the west so would not be conducive for failure along a linear trend (Figure 4). Thus it is reasonable to assume that failure occurs along traces of the Alexander-Redwood Hill fault. Olsborg and Vincilione (1988) reported soil-filled fissures associated with fault planes in trenches excavated across this linear trough, supporting the assumption that ridgetop spreading has played a part in the formation or enhancement of the linear trough. However, there is a paucity of mapped landslides along the slopes flanking the ridgetop trough.

Brooks Creek

Tributary drainages along the east side of Brooks Creek do appear to have been vertically displaced, based on field inspection by this writer (Photo 3). Uplifted Holocene terraces representing the tributary's former base level are at least 1.7 meters above the active channel of Brooks Creek (localities 12 and 13, Figure 2b). Terrace levels on the southwest side of Brooks Creek (west of or on the downthrown side of the fault) are at approximately the same height as the "uplifted" terraces thought to have been produced by faulting (Photo 4). This demonstrates a lack of vertical offset. Rather, incision by Brooks Creek, probably in response to base level changes due to regional deformation of the block between the Rodgers Creek/Healdsburg and Maacama faults (Fox, 1983), has caused the relatively rapid downcutting of the tributary drainages, mimicking vertical displacement.

Moderately indurated sandstone and interbedded conglomerate of the Glen Ellen Formation was observed at locality 13 (Figure 2b). The east-dipping beds form an anti-dip slope modified by lateral stream erosion where the west-facing scarp of the eastern strand of the Alexander-Redwood Hill fault has been mapped. The Glen Ellen Formation exposed here lacks evidence of shearing or fracturing as might be expected within such close proximity to the mapped fault. Glen Ellen Formation also crops out on the west side of Brooks Creek and exhibits bedding attitudes nearly identical to the rocks exposed on the east side of Brooks Creek (locality 14, Figure 2b), indicating that the fault here is probably a bedding plane feature. It seems reasonable to conclude that Brooks Creek is an erosional trough rather than a graben formed by recent extensional deformation.

SEISMICITY

Seismicity in the Shiloh Ranch/Brooks Creek study area principally occurs on the northern Rodgers Creek fault, the southern Healdsburg fault, and in a diffuse pattern along the southern Maacama fault (CIT, 1985). There is no well-defined linear pattern of epicenters aligned with the Alexander-Redwood Hill fault. A few epicenters of M 1-1.9 are randomly arrayed within about two kilometers of the Alexander-Redwood Hill fault.

CONCLUSIONS

The Alexander-Redwood Hill fault is a moderately defined to locally poorly defined, 20km long fault zone that has been described variously as a right-lateral strike-slip fault, a normal fault with down-to-the-west displacement, or an oblique-slip fault. Cumulative offset has not been determined, but a ridge formed in Plio-Pleistocene Glen Ellen Formation is right-laterally deflected about 260 meters. Geomorphic expression of the Alexander-Redwood Hill fault is consistent with a Quaternary active strike-slip fault. However, the fault generally lacks geomorphic evidence of Holocene strike-slip or normal displacement and faults mapped by Blake and others (1971), Armstrong (1977, 1978), and Olsborg and Vincilione (1988) mostly were not verified as Holocene by this writer (Figures 2a-2c).

Vertically offset, or "hanging", drainages associated with a linear west-facing scarp at Brooks Creek were reported as evidence of Holocene displacement along the Alexander-Redwood Hill fault by Armstrong (1978) and Olsborg and Vincilione (1988) (e.g. localities 4, 12, and 13, Figure 2b). The west-facing scarp in Plio-Pleistocene Glen Ellen Formation is actually a series of slightly arcuate scarps formed or enhanced by lateral stream erosion, based on field observations by this writer. The vertically offset drainages reported by Armstrong (1978) and Olsborg and Vincilione (1988) were only partly verified by this writer, based on field inspection (localities 12 and 13, Figure 2b). Terrace levels on either side of the fault are at the same elevation, strongly indicating that the recent incision of these tributary drainages is due to local base level changes of Brooks Creek (Figure 2b). The terrace levels were only estimated based on leveling by Brunton compass, so differential vertical displacement of a few centimeters cannot be ruled out. Further arguments for a lack of significant recent offset along the fault in Brooks Creek include similar bedding attitudes in the Glen Ellen Formation on the west side of Brooks Creek (locality 14, Figure 2b) and the lack of significant fracturing or shear fabric in moderately indurated beds of the Glen Ellen Formation exposed within about 3 meters of the mapped trace of the fault (locality 13, Figure 2b).

A 2 km long strand of the southern Alexander-Redwood Hill fault exhibits geomorphic evidence of latest Pleistocene to Holocene extension (south of locality 11, Figures 2c and 3). A moderately well-defined ridgetop trough associated with a closed depression and linear tonal contrasts was trenched by Olsborg and Vincilione (1988) and Olsborg and Graff (1990) (Figures 2c and 3). The trough is bounded on the east and west sides by faults that offset Sonoma Volcanics. The faults extended to within about 1 meter of the ground surface and offset colluvial deposits of probable late Pleistocene to early Holocene age. It is quite possible, however, that recent displacement along this 2 km long segment of the Alexander-Redwood Hill fault has been caused or at least enhanced by ridgetop spreading. It is similar in some respects to the fissuring associated with the 1989 Loma Prieta earthquake (Hart and others, 1990), such as the cross sectional shape of the ridge (Figure 4), the graben-like configuration of the offset colluvium, and the presence of soil-filled fissures reported by Olsborg and Vincilione (1988). However, the linear extent of the trough (2km) is much greater than any one fissure or trough observed on Summit Ridge (700 meters), there are only a few landslides mapped in the area, and the trough lacks sinuosity. Although ridgetop spreading cannot be ruled out, it seems prudent to assume that tectonic deformation has produced a significant part of the ridgetop trough.

RECOMMENDATIONS

Recommendations for zoning faults for special studies are based on the criteria of "sufficiently active" and "well-defined" (Hart, 1990).

Zone for special studies well-defined traces of the Alexander-Redwood Hill fault shown in Figure 3. Principal references cited should be Olsborg and Vincilione (1988) and Bryant (this report).

Do not zone for special studies traces of the Alexander-Redwood Hill fault northwest of the Mark West Springs quadrangle. These faults are neither sufficiently active nor well-defined.

I have reviewed the air photos and this report and agree with your conclusions & recommendations
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CEG 935
5/22/92

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May 7, 1992

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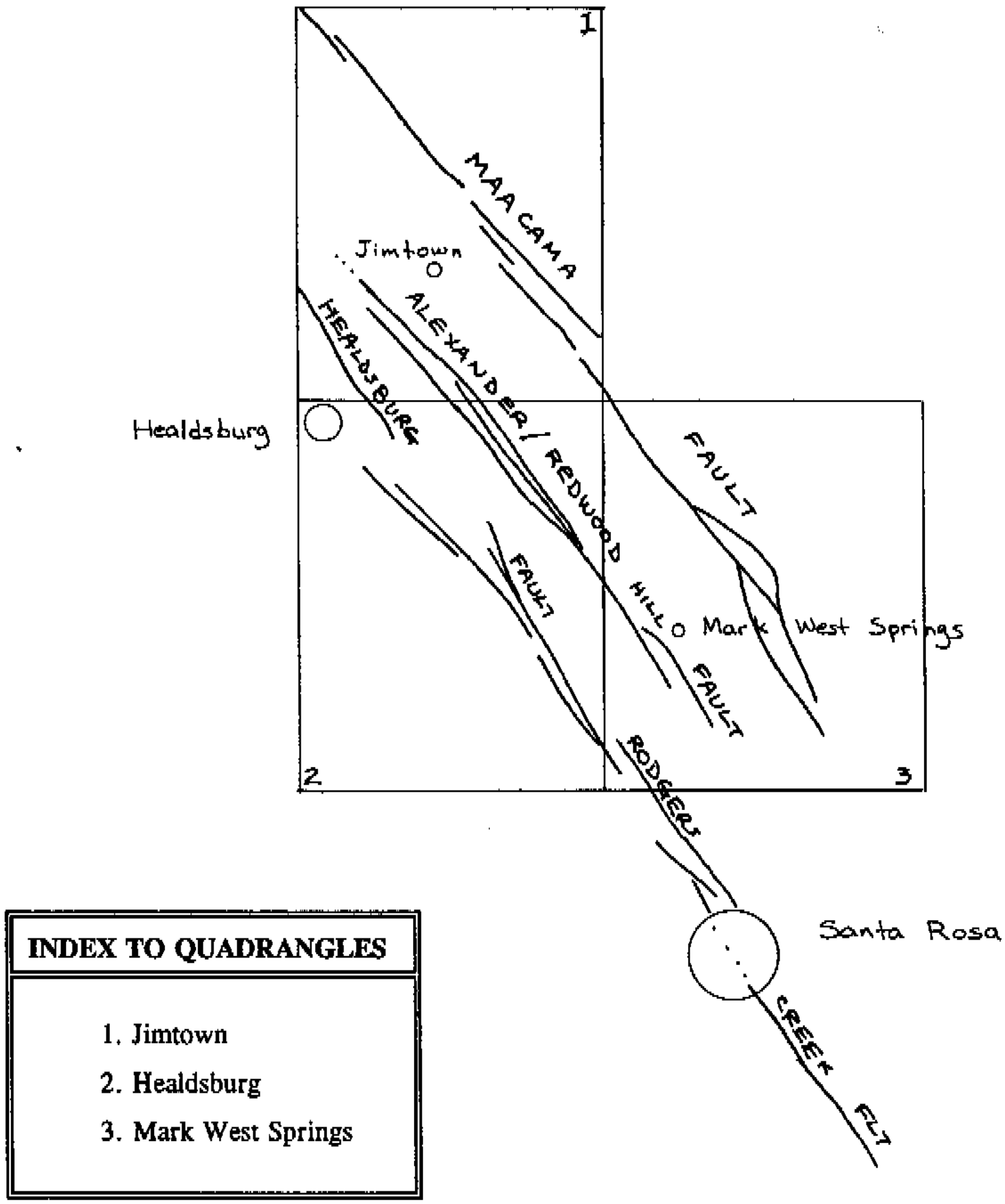
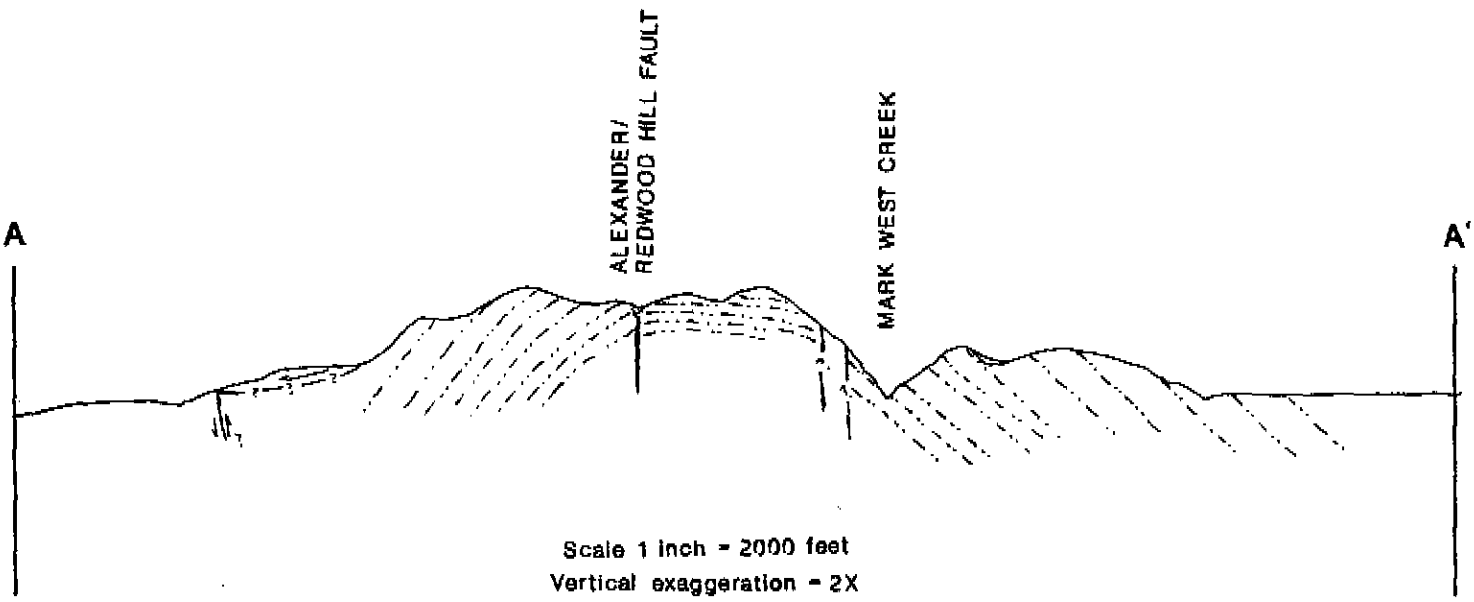


Figure 1 (to FER-233). Location of the Alexander/Redwood Hill fault in the Shiloh Ranch/Brooks Creek study area. Fault traces are generalized from Wagner and Bortugno (1982), scale 1:250,000.



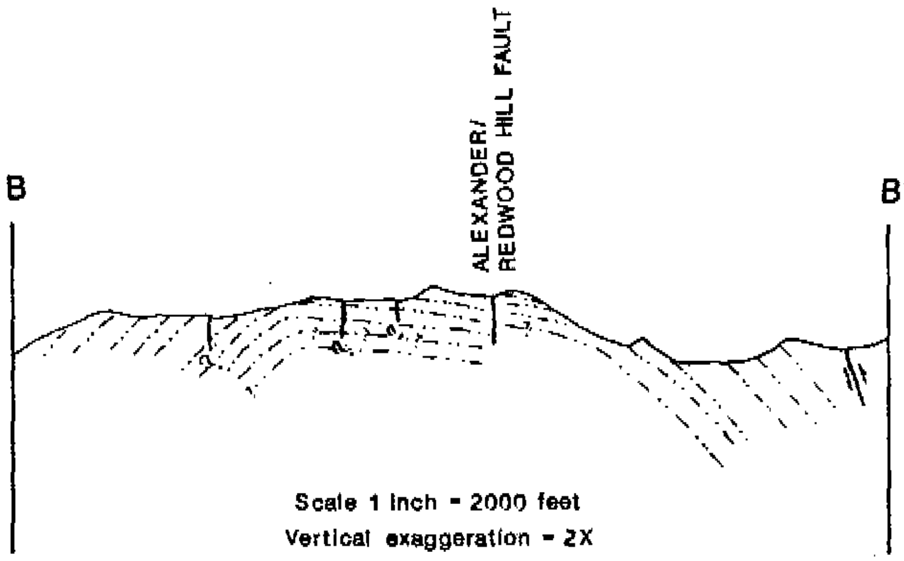


Figure 4 (to FER-233). Topographic profiles and schematic cross sections A-A′ and B-B′ across the linear ridge-top trough in the Mark West Springs quadrangle. Refer to Figure 3 for location of profiles.

A

B

Photo 3 (to FER-233). **A.** View east toward the west-facing escarpment delineating the Alexander/Redwood Hill fault in Brooks Creek. Northeast-dipping Plio-Pleistocene Glen Ellen Formation, exposed in the center of the photo, forms strike-ridges along the east side of Brooks Creek. The recently incised tributary drainage (indicated by arrow) was thought by Armstrong (1978) and Olsborg and Vincilione (1988) to indicate recent offset along the Alexander/Redwood Hill fault. Terrace levels on the southwest side of the fault in the floodplain of Brooks Creek are at approximately the same height as the "uplifted" terraces thought to have been produced by faulting (see Photo 4). This demonstrates a lack of vertical offset. Rather, incision by Brooks Creek, probably in response to regional base level changes, has caused the relatively rapid downcutting of the tributary drainages, creating the illusion of vertical uplift. **B.** Close-up of incised drainage outlined in Photo A (note rock hammer for scale).

Photo 1 (to FER-233). View north along linear ridgetop trough delineating the Alexander/Redwood Hill fault in the Mark West Springs quadrangle. The trough has been dammed (arrow indicates location of one of three dams) and serves as a reservoir for the Shiloh Ranch development.

Photo 2 (to FER-233). View northwest along linear trough northwest of the dam shown in Photo 1. The fault changes to a more westerly trend as indicated by the dashed lines in the background. A closed depression (marked as a vernal pool by the developer) is indicated by the arrow in the foreground.

Photo 4 (to FER-233). View northwest along the west side of Brooks Creek, showing at least 4 terrace levels indicated by numbers 1-4 (1 youngest, 4 oldest). Terrace number 2 is at approximately the same elevation as the apparent uplifted terrace isolated by rapid stream incision at locality 12 (Figure 2b, Photo 3).